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DIGITAL MAPPING OF HURST CASTLE SPIT, HAMPSHIRE

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ABSTRACT

This paper serves two purposes. The first is to make available to the geomorphological community the first in a short series of up-to-date digital maps of 'classic' coastal landforms of the U.K. – Hurst Castle Spit. The second is to demonstrate that conventional surveying techniques and readily available graphics software on a PC or Mackintosh will provide an entry into digital mapping for geomorphological applications. Comments are included on how the digital map may be utilized.

KEY WORDS Hurst Castle Spit; coastal geomorphology; digital mapping

INTRODUCTION

In few other parts of the Earth's surface does there exist as much potential for change in a short timescale as at the coast. Inevitably, much of this regular change, in particular the sedimentary structures and landforms, goes unrecorded. Although the United Kingdom has two major mapping organizations which include the coastal zone within their remit, in practice neither the nature of the mapped information nor the frequency of the surveys are ideal from the point of view of an Earth scientist concerned with the evolution of landforms. From the particular standpoint of the coastal geomorphologist, neither the topographic maps of the Ordnance Survey nor the coastal charts of the Hydrographic Office of the Admiralty do justice to the intertidal and back-shore zones. This point does not need labouring – an inspection of the generalization and symbolization applied to cliffs, sand dunes, beaches and salt marshes will reveal a dearth of morphological information and a maximum of over-simplification. This is not a criticism of either organization, but a recognition of the fact that their mapping specifications require priorities elsewhere.

It is for this reason that detailed morphological studies of the coast have often necessitated dedicated maps being produced, traditionally by ground, but later by aerial survey methods (Collin and Chisholm, 1991). J. A. Steers' great work on the coastline of England and Wales (Steers, 1946) is a prime source of some of the early examples of such maps (Blakeney Point, Morfa Harlech and Dawlish Warren, for example), which are often works of some style. However, since maps are more often simply a means to an end, it is frequently the case that many such documents have never received wide circulation, perhaps residing solely in dissertations or theses buried deep in university library store-rooms. An examination of the literature reveals few recent examples, though sometimes maps are referred to as being available, rather than actually being completely included in the related academic paper (Kidson *et al.*, 1989; Kirby, 1993).

It is with this background in mind that the proposal for this series of articles was made. It is arguably time that, for consumption by the wide community of geomorphologists at all levels, some of the accepted classic coastal landforms of Britain were brought up to date. When maps of such features as Dawlish Warren, Spurn Head, Dungeness Foreland, Blakeney Point, Hurst Castle Spit, Orford Ness and the like are unavailable, there is a need to be met. The map of Hurst Castle Spit associated with this article, which is anticipated to be the first of a series, will fill one such gap. Part of the aim is to establish a consistent and appropriate

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specification for all the maps, which will also be surveyed as closely as practicably possible to the date of publication.

The complementary aspect of bringing these features up to date is that not just the content, but the medium, should reflect the ways in which maps are presented and used in the 1990s. Again, making reference to the products of the Ordnance Survey and Hydrographic Office, though many traditional paper maps are still being sold, an increasing number of users are acquiring mapped information in digital form to incorporate into Land and Geographic Information Systems, or to exploit the inherent flexibility of these data in terms of editing facilities and merging with in-house information. So the culture is changing, and it is hoped that this article will demonstrate how straightforward it is to produce specialist geomorphological maps in a digital form that will stimulate the widest possible use.

The intention is not for the author to carry out any analysis of recent change in the one landform presented, revealing as such a study might potentially be, but rather to provide the information which will make possible the completion of such an appraisal by others.

THE DIGITAL MAPPING PROCESS

Although digital mapping is scarcely new, the methods by which data have been captured, processed and presented have, until recently, been relatively specialist. In national mapping organizations or commercial companies the process would have involved the following stages.

1. Survey and plotting of planimetric and height data, as determined by the mapping requirement and associated specification. In the case of aerial survey, the processes are integrated and the first graphic product will appear at the survey stage; in ground survey identifiably separate stages would be involved.
2. Digital data capture. Use of a large flatbed digitizer in the manual capture and encoding of all point and line details, directly digitizing the graphic product to produce a vector map file.
3. Creation of a digital map data bank. All of the individual maps combined together by appropriate numerical manipulation.
4. Provision of the mapped data to users. *Either* plotting of standard or user-defined graphical products *or* provision of digital data under licence for project-related manipulation by the user.

Over the last few years, this system has evolved in a number of ways. Capture of data at the actual survey stage in digital form is now fairly routine. In the case of ground survey, electronic measuring devices, data loggers and resident software mean that stages 1 to 3 might be a direct link, with possible intermediate viewing of a 'field' plot at stage 1 for visual verification. With aerial survey, data can similarly be obtained digitally, either in a suitably modified traditional (analogue) photogrammetric plotter or a digital (analytical) instrument with suitable software, and again fed directly into the digital data bank. In both cases, the description of the category of the information – the encoding – will take place at the time of data capture.

The later provision of the mapped information to the user, stage 4, is a particular point of interest. Given the range of potential applications and varying computer facilities, the nature of the computer medium (tapes, floppy disks, CD-ROMs) and the transfer formats (.NTF, .DXF, .TIF, etc.) have been very significant. Although the original map data is most often in an encoded, vector-based format, still capable of being edited, there has also been the development of cheaper, raster-digitized products, where the user will only be able to utilize the map image as an underlay to other spatial data sets.

What are the implications of all this for the earth scientist and the geomorphologist in particular? Firstly, the process as presented, whether or not it embraces recent developments, continues to include a number of quite specialist skills. Most geomorphologists have some surveying expertise, though perhaps only with traditional ground survey instrumentation, but the other stages in the process demand something new from them, something they might prefer to entrust to others. Secondly, the process is costly. Both digital ground survey and digital aerial survey involve the use of expensive instrumentation, and related computer hardware, software and technical support are also potentially costly. Notwithstanding these drawbacks, the world of digital mapping *is* becoming more accessible, thanks to the ubiquity of PCs and low-cost graphical software.

While the sophisticated processes outlined above in general terms may continue to be the way in which major organizations will undertake map production (Newby and Walker, 1986), less well resourced researchers might care to consider the simpler approach described in this case study. The means to produce a conventional, graphical survey plot by either ground or aerial survey is assumed; the interest is in how this can be converted into digital data in a form accessible to other users.

THE LANDFORM: HURST CASTLE SPIT

Hurst Castle Spit is a key feature at the western entry to the Solent, in Hampshire. In simple terms the spit represents the eastward prolongation of a pronounced drift of sand and shingle derived from the soft Tertiary cliffs of Christchurch and Barton Bays. The spit is also a vital element in the noted sedimentary circulatory system which includes the offshore Shingles Bank (Figure 1). Disruptions to the offshore circulation

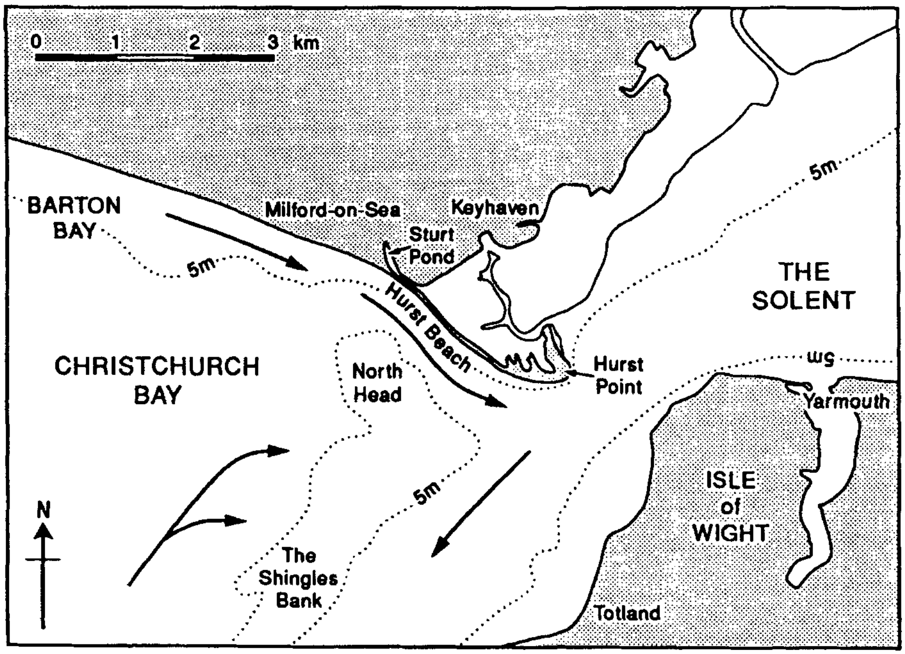

Figure 1. Hurst Castle Spit: general location and main offshore circulation

might well have a dramatic effect on Hurst Castle Spit, but it is already a highly vulnerable landform due to other processes and to man's impact. The spit has been observed to be retreating across the associated intertidal marshes at rates of up to $5\,\mathrm{m\,a^{-1}}$ (Nicholls, 1984; Nicholls and Webber, 1987). Reduction of natural longshore sediment supply due to extensive groyne systems and some cliff stabilization further westwards has been offset recently by expensive artificial beach nourishment. The anchoring of the distal end by Hurst Castle itself is a management complication which has prompted extensive defensive and sediment retention measures in the vicinity of the castle. The natural evolution implied by the notable shingle recurves may not be so easy to halt and the spit faces an interesting future.

Undeniably, this is one of the classic coastal landforms of the U.K., arguably in one of the most crucial locations, and, as such, commands the interests of both geomorphologists and coastal managers at a variety of levels.

THE 1995 SURVEY

The map data presented is a straightforward photogrammetric survey based on 1:5000 scale colour photography, flown at low tide in July 1995. Five steroscopic overlaps were involved and, for each, a 1:2500 scale

graphic plot was completed by the author on a Kern PG2-L stereoplotter. Details of the specification are apparent on the map itself, but a thorough topographical and morphological map was produced, containing as much information as possible at the chosen plotting scale. Mean high and low water marks were surveyed in detail, having been computed from the Admiralty Tide Tables in the approved manner.

DIGITAL CARTOGRAPHY

The thrust of this paper is that commonly available, low-cost graphics software like Coreldraw! and Adobe Illustrator is perfectly adequate as a gateway to digital map creation and transfer. Though such software may not be mastered with the speed and facility of many other PC or Mac packages, such as word-processing, spreadsheets, databases and desktop publishing, reasonable familiarity can nevertheless be quite quickly gained. However, it should also be acknowledged in honesty that both packages noted considerably repay experience and accumulated expertise. The required microcomputers are everywhere and the scanners and plotting or printing devices are also becoming commonplace as prices fall in real terms.

For the purposes of this project, each photogrammetric plot was scanned at original scale, in colour, on an Epson GT-8000 at 300 dots per inch (dpi). The bitmap files created were imported into Adobe Illustrator and Adobe Photoshop software mounted, in this case, on a Mackintosh LC-475. Within Photoshop, the colour bitmap image was traced and then imported into Illustrator for use as a template for the creation of a vector image file. A combination of Corel Photopaint and Coreldraw! on a PC would have been equally appropriate. In due course, the Illustrator file was edited, with colour linework, varying line weights and symbols, colour areal fills and lettering being applied as appropriate; the principle of placing different details, in different colours, on 'layers', was employed. Final reorientation, map layout and addition of ancillary elements were then undertaken to produce the complete digital map file. In the chosen Illustrator v 5.0 format (.AI), this produced an image file of approximately 0·8 Mb size, which is very modest relative to the amount of detail included in the map.

In relation to the previously outlined digital mapping process, this effectively replaces stage 2 without recourse to any specialist or expensive hardware and software. Adobe Illustrator costs something of the order of £280 for v 5.0, Adobe Photoshop v 4.0 about the same and Coreldraw! (which includes Photopaint) varies from v 3.0 at an incredible £40 to v 5.0 at £280. The two packages will mutually import files, though some minor modifications may be necessary after import.

MAKING THE MAP AVAILABLE IN DIGITAL FORM

An option considered for presenting the map with the *Bulletin*, which it was felt might make it most widely available, even to software like Windows Paintbrush, was to convert the vector image file into some form of bitmap image. TIFF format (.TIF) was considered, being the most flexible and widely supported. However, the 0·8 Mb colour vector file converted into a 20 Mb colour raster file, even at a resolution of only 300 dpi. Even with data compression, this could just be brought down to a size small enough for a floppy disk, though the possible related requirement for decompression software on the diskette would have made this marginal. However, the key factor was not file size, but the lack of visual quality in the resulting image.

A further option investigated was to convert the image file into a DXF format (.DXF), to make the vector file compatible with AutoCAD and similar CAD software or Geographic Information Systems (GIS). This also resulted in an increase in the size of the image file to about 14 Mb, uncompressed. Given that most CAD software and many GIS will directly import Illustrator or Coreldraw! formats, such a translation is unnecessary.

Ultimately, therefore, the map image is presented in its original vector form, as both an Illustrator (.AI) file for Mackintosh and as a Coreldraw! (.CDR) file for PC, the former only being available on request however. In both cases, the image file is kept down to an acceptable size with only minor compromises being necessary:

(1) The level of information included clearly affects the size of the image file. The greater the map content, including ancillary elements (key, title, grid, linescale), the bigger the file.

(2) The complexity of the linework. In a vector file, simple linework produces less nodes, while complex and sinuous lines produce more nodes. The effect is difficult to gauge, but this is a key factor in image file size.
(3) Use of colour and symbols. This is only a minor factor, but the use of simple, standard colours for areal fills is preferable to customized colours and more complex areal symbols (including postscript fills). This has some effect on the image size, but will have a more important effect on the importability of the image file into alternative graphics software packages.

PRACTICAL MANIPULATION OF THE MAP IMAGE FILE

In broad terms, the map image file supplied in the journal may either be used and manipulated solely as part of a video display or it may be printed out as a hard-copy map. Neither of these should prove any problem for those possessing Illustrator or Coreldraw! software. Several alternative graphics packages will also be able to access this data, though the importing of .CDR and .AI formats is not entirely universal in lower-end graphics software. For manipulation in some other packages, conversion into raster format, by suitable export from Coreldraw! or Illustrator, may be an alternative—several standard rasterised export options exist (.PCX, .BMP, .TIF, .GIF, .TGA, etc.). As previously noted, the loss of resolution involved in such a transformation is considerable, and not to be recommended for serious users of the map.

The prevailing view is that Coreldraw! is now so common and so cheap to buy (in v 3.0) that PC users are urged to apply this as the means of handling the image file. Once the images are imported and on screen, a number of manipulations are then possible prior to use of the map. It should be understood, as indicated earlier, that details have been drawn in different colours on different 'layers', but that these will have been combined or 'grouped' for final presentation.

(1) *Opening the file* Assuming that the graphics package is Coreldraw!, the image file (HURST.CDR) can be read direct. However, as such a complex floppy disk image file is relatively fragile, it is recommended that the file is firstly copied onto the PC hard disk and subsequently opened from there (keeping the floppy version as a backup). The image file may then be imported from the hard disk into other compatible graphics software.
(2) *Viewing the image* Once on-screen, the map image may be readily viewed at any scale. The fine resolution of the vector image becomes apparent if a high level of zoom is applied. In viewing and otherwise manipulating the image the specification of the PC will be important—it is unlikely that processors less than 486DX and RAM less than 12 Mb will be totally satisfactory; with the current state of PC technology and prices, mounting Coreldraw! or other graphics software on a platform less than this seems unwise.
(3) *Manipulating the image* It is difficult to see why users might wish to alter parts of the image, but if colours are to be changed, details amended, additional details added or naming applied, then the image file must be firstly be 'ungrouped'. Some knowledge of the Coreldraw! functions is then required, and these cannot be dealt with here.
(4) *Printing* One of the choices in printing is the nature of the printer; ideally this should be either a colour laser or a colour inkjet, with a minimum resolution of 300 dpi. All or part of the image may be printed, at whatever scale is thought appropriate; the use of standard 1 : 2500, 1 : 5000 or 1 : 10,000 scales facilitate comparison with other published maps. For compactness of transfer, the image file is actually at 1 : 5000, so the three scales noted imply 200%, 100% and 50% plotting respectively. The 1 : 10,000 fits nicely on an A4 page, but the complete 1 : 2500 requires 11 'tiled' plots. Some loss of line clarity will be evident at 1 : 10,000 as the resolution of the plotter becomes significant and Coreldraw! does not automatically adjust plotted line weights with varying scale. The option of printing selected details only does not exist with the supplied Coreldraw! version of the image file, though MAC users would find that this is possible with the Illustrator image file alternatively available.
(5) *Exporting* The major context in which export is likely is if the map is to be used in low-end graphics software like Microsoft Paintbrush. As noted earlier, a wide range of raster or bitmap export formats are available within Coreldraw! but the associated loss in image resolution will be considerable and

the increase in size of image file unacceptably large. CAD or GIS applications may also encounter resolution losses and colour changes, depending on how the file is imported into these environments.

SUMMARY

In principle, the aim of this first exercise was to produce a non-commercial map and make it widely available in a digital rather than a graphic format. Within the vast computer industry, the transmission of software or data, often free, with publications, is very well established, but in academic publishing it is still far from the norm. Doubtless, however, digital data as a component in academic journals will become commonplace in the next few years. The article represents an experiment by a geomorphologist in making a quite complex landform map available in this way. By the time later maps in the series are produced, new technology, such as recordable CD-ROMs, will undoubtedly have modified some of the constraints presently encountered.

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